#2
DRW
4-16-02

January 14, 2002

INFORMATION DISCLOSURE STATEMENT letter

To Whom It May Concern:

The following documents are included in form PTO/SB/08A Information Disclosure Statement by Applicant as a bibliography for the application having the following title and applicant.

Title: Digital Images with Composite Exposure

Applicant: Charles D. Murphy

Here, the documents are discussed as they relate to the specification and claims of the application.

The present invention proposes a digital imaging technique in which members of a set of digital images of a field of view are arithmetically combined to form a composite digital image of the field of view. At least one of the digital images includes a pixel which represents the output of a sensor that responds to visible light. The composite digital image can have different exposure properties than the digital images in the set. For instance, pixels in the composite digital image can have differing exposure times than their counterparts in the digital images. Also, the invention can be used to compensate for or enhance effects such as motion blur and flash illumination. A key feature of the invention is the ability to provide desired exposure properties for interesting features in the field of view after the digital images have been acquired. This enables novice image-takers to make good composite digital images. Different viewers may produce different composite digital images on the basis of different features of interest as long as the information contained in the digital images has not been discarded.

Many prior art techniques for digital imaging make use of image combination.

A well-established technique in both analog and digital imaging is photomontage. In photomontage, an image of one field of view is combined with an image of another field of view to create a third image of a field of view that never existed. For instance, one might create an image of a city skyline on the night of a full moon, with the full moon replaced by an image of the planet earth taken from space. As another example, one image of a field of view containing a person might be combined with another image containing the same person, making it appear that the person was in two locations simultaneously.

Photomontage is mainly intended as a form of art. The composite image may suggest various ideas to viewers on the basis of the various fields of view and their features that appear in the composite image. The effect of combining two images may be to startle the viewer, as in the examples given above. Alternatively, the viewer may not even realize that the field of view of the combined image was not an actual field of view for which an image was acquired.

The main difference between photomontage and the present invention is that photomontage creates an artificial field of view, whereas the present invention attempts to combine different digital images of an actual field of view to create a composite digital image of that actual field of view. There are embodiments of the present invention that compensate for or enhance the effects of motion of features of a field of view. Their purpose is not to create an artificial field of view, but to produce an image that is either a near-instantaneous representation of an actual field of view, or a representation of an actual field of view in which there is motion and in which it is desired that the motion be imaged. In the case of compensation, there was an actual time period when the imaged objects occupied the near-instantaneous positions. In the case of enhancement, there was an actual time period when the objects moved through a trajectory between a starting location and an ending location. Both enhancement of and compensation for motion in the present invention exploit the fact that information about relative positions or sets of relative positions is preserved in the digital images, whereas in a single image of longer duration the information is lost.

It is possible to take a first digital image of a field of view and modify it by photomontage to produce a first modified digital image of an artificial field of view. Subsequently, the first modified digital image could be combined with a second digital image of the field of view. It is desired that a trivial modification which does not serve a useful purpose other than to avoid the language of the claims of the present invention, but which has substantially the same intended results as the present invention, be considered covered by the claims.

In other words, the term "field of view" should be interpreted as referring to a set of features that during acquisition of an image are located in particular relative locations, or, in the case of motion, that are located in particular sets of relative locations. If, during acquisition of a second image, substantially the same set of features are located in substantially the same relative locations or sets of relative locations, the second image is of the same field of view as the first image. If the second image of the same field of view is modified, but still comprises substantially the same set of features located in substantially the same relative positions, the modified image should be considered still to be of the same field of view.

Digital image acquisition techniques using sensor arrays typically produce large numbers of analog sensor outputs that must be converted to digital number values. The conversion usually takes place either one sensor output at a time or with small groups of sensor outputs converted simultaneously. The acquired digital image is simply the set of digital number values produced by the conversion process. However, the set of all digital number values produced by the conversion process with one number removed is clearly not identical. For instance, an acquired digital image less the digital number value of an arbitrary pixel is not identical to the acquired digital image.

As another example, a color digital image is usually composed of triplets of digital number values. Each pixel may have a red value, a blue value, and a green value, for instance. Thus a color digital image can be considered as composed of a red digital image, a blue digital image, and a green digital image.

The progressive or interlaced scan techniques used to process analog sensor outputs into digital number values result in the building of a set of digital number values that compose a digital image. Likewise, color digital images are sets of digital number value triplets.

With regard to the present invention, combining of digital number values by creating sets is not the same as arithmetic combining. In arithmetic combining, digital number values are modified using basic operations such as addition, multiplication, subtraction, truncation, rounding, or other operations. Thus, the present invention should not have any conflicts with prior art digital image scanning techniques or multi-spectral digital images.

Prior art methods for radar imaging and sonar imaging are numerous. In most radar and sonar applications, there is an active source of illumination, usually of short duration. The imaging systems emit a pulse, which propagates from the source, reflects from some features in the field of view, and returns to a sensor array. The pulse may be short so that the same device can emit it and sense the return signal. However, a more important reason for having a short pulse is that the distance to various features in the field of view can be determined on the basis of the round-trip travel time of the pulse.

Most radar and sonar imaging systems produce a time series of sensor outputs. There are often a small number of sensors whose outputs are measured at a large number of time epochs. A digital image of the field of view is formed by combining the digitized outputs from the various sensors at the various times. It is certainly possible to consider the digitized outputs of the sensor array at one sampling time as a digital image, which is arithmetically combined with the digitized outputs of the sensor array at other sampling times to produce a final digital image. This interpretation is quite similar to the core idea of the present invention, and is a reason for limiting the present invention by requiring a digital image in the first set with a digital number value representing the output of a sensor that responds to visible light.

The aim of the present invention is exposure adjustment in digital imaging with visible light, where one digital image is usually a set of digital numbers representing simultaneous measurements of a large array of sensors. An individual regarding such a digital image can usually identify whether it is overexposed, underexposed, or properly exposed. Moreover, the individual can also discern the exposure properties of features that interest him or her. The present invention is intended to enable easy image acquisition and exposure adjustment by people unskilled in the art of digital imaging. On the other hand, a radar or a sonar image composed of one set of sensor measurements at one time instant generally is not easily interpreted by either a layperson or an expert. The digital images from the combined sensor outputs at the various sampling times is required to provide immediately useful information and an expert is needed for interpretation.

US Patent 6,330,302 "Method of and device for forming an image of an object from a plurality of images", issued to J.H.M. Joosten on December 11, 2001 and US Patent 5,436,952 "Telerecording system for x-ray images having a semiconductor image

converter" issued to J. Haendle and H. Horbaschek on July 25, 1995 represent prior art material from the area of medical x-ray imaging. Specifically, the patents deal with x-ray imaging in which there is a source of x-rays and an x-ray sensor or sensor array.

X-rays are not visible light, and the present invention requires that one of the digital images of the field of view include a digital number value representing a sensor that responds to visible light. The goal of medical x-ray imaging is to provide images of internal body parts without any kind of intrusive surgery. Most people are familiar with x-ray images as a way of identifying broken bones. The x-rays pass through the human body, and attenuation of the x-rays provides variation in acquired images.

It has been recognized for a long time that there are basically two types of tissue in the human body. Hard tissue, namely, bone tissue, absorbs x-rays at a particular rate for a given x-ray energy. Soft tissue such as flesh, on the other hand, absorbs x-rays at a much different rate. An x-ray energy or duration that produces desired sensor response variation for a hard tissue feature may produce little useful variation for a soft tissue feature. An x-ray energy or duration that produces desired sensor response variation for a soft tissue feature may produce little useful variation of a hard tissue feature. Thus, one type of x-ray is useful for imaging hard tissue, and another type of x-ray is useful for imaging soft tissue.

The prior art of US Patents 6,330,302 and 5,436,952 proposes combining two or more x-ray images in order to produce a composite image in which hard tissue features and soft tissue features both have desired variation. The combining can be arithmetic combining.

Another area of prior art is image joining. For instance, US Patent 5,982,951 "Apparatus and method for combining a plurality of image" issued to T. Katayama, H. Takiguchi, K. Yanoa, and K. Hatori on November 9, 1999 describes how to create a panoramic image of a large field of view from smaller images of smaller, different fields of view.

The main features of image joining techniques are, first, identification of overlapping regions and establishing of proper relative locations for the images being joined, and second, modifying digital number values so that there are no joining artifacts such as an obvious boundary line of the overlapping region in the joined image. Image joining techniques can use arithmetic combining, for instance, to gradually shift contributions from one image to the other across the region of overlap.

Image joining techniques differ from the present invention in several respects. Image joining techniques use images with different fields of view, whereas the present invention uses digital images with a single field of view. The different fields of view in image joining have small regions of overlap. The fields of view in the present invention are substantially entirely overlapping. Also, the goal of image joining is to create composite digital image of an artificial field of view. That is, the panoramic field of view never existed as a set of features all contributing to a single acquired image. In contrast, the present invention is intended to improve the exposure properties a composite digital image of an actual field of view via arithmetic combination of several digital images of the actual field of view.

I, the inventor of the present invention, have been unable to find any prior art closely similar to the material of the present invention other than the prior art discussed above. To the best of my knowledge, the idea of using several digital images of a field of view to produce a composite digital image of that field of view is new and deserving of patent protection.

This concludes this INFORMATION DISCLOSURE STATEMENT letter.

Sincerely,

Charles D. Murphy

Charles D. Murphy
1816 West Wilson Avenue #3
Chicago, IL 60640

Please type a plus sign (+) inside this box →

PTO/SB/08A (08-00)
Approved for use through 10/31/2002. OMB 0651-0031
U.S. Patent and Trademark Office: U.S. DEPARTMENT OF COMMERCE

Under the Paperwork Reduction Act of 1995, no persons are required to respond to a collection of information unless it contains a valid OMB control number.

Substitute for form 1449A/PTO

INFORMATION DISCLOSURE STATEMENT BY APPLICANT

(use as many sheets as necessary)

Sheet 1 of 1

Complete if Known	
Application Number	
Filing Date	
First Named Inventor	Charles D. Murphy
Group Art Unit	
Examiner Name	
Attorney Docket Number	

U.S. PATENT DOCUMENTS

Examiner Initials*	Cite No.[1]	U.S. Patent Document Number	Kind Code[2] (if known)	Name of Patentee or Applicant of Cited Document	Date of Publication of Cited Document MM-DD-YYYY	Pages, Columns, Lines, Where Relevant Passages or Relevant Figures Appear
		6330302		J.H.M. Joosten	12-11-2001	
		5436952		J. Haendle, H. Horbaschek	7-25-1995	
		5982951		T. Katayama et al.	11-09-1999	

FOREIGN PATENT DOCUMENTS

Examiner Initials*	Cite No.[1]	Foreign Patent Document Office[3]	Number[4]	Kind Code[5] (if known)	Name of Patentee or Applicant of Cited Document	Date of Publication of Cited Document MM-DD-YYYY	Pages, Columns, Lines, Where Relevant Passages or Relevant Figures Appear	T[6]

Examiner Signature		Date Considered	

*EXAMINER: Initial if reference considered, whether or not citation is in conformance with MPEP 609. Draw line through citation if not in conformance and not considered. Include copy of this form with next communication to applicant.

[1] Unique citation designation number. [2] See attached Kinds of U.S. Patent Documents. [3] Enter Office that issued the document, by the two-letter code (WIPO Standard ST.3). [4] For Japanese patent documents, the indication of the year of the reign of the Emperor must precede the serial number of the patent document. [5] Kind of document by the appropriate symbols as indicated on the document under WIPO Standard ST. 16 if possible. [6] Applicant is to place a check mark here if English language Translation is attached.

Burden Hour Statement: This form is estimated to take 2.0 hours to complete. Time will vary depending upon the needs of the individual case. Any comments on the amount of time you are required to complete this form should be sent to the Chief Information Officer, U. S. Patent and Trademark Office, Washington, DC 20231. DO NOT SEND FEES OR COMPLETED FORMS TO THIS ADDRESS. SEND TO: Assistant Commissioner for Patents, Washington, DC 20231.